Principles of Radiation Detection

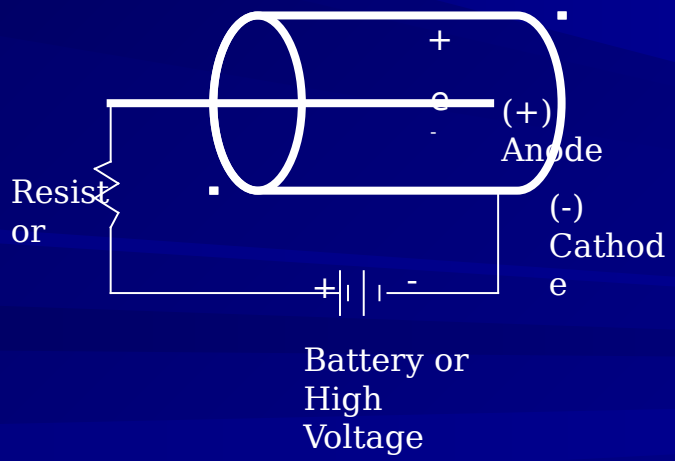
Operational Radiological Safety Course
U.S. Army Chemical Biological Radiological & Nuclear School
Edwin R. Bradley Radiological Lab
031RDB01

Two Main Principles of Radiation Detection

- Electrical collection of ions
  - Air Ionization
  - Gas Ionization
- Scintillation
  - Light Production

Ionization Chamber

- Electrical collection of ions
- No gas amplification (air)
- Used to measure dose rate
- Sensitive to environmental changes



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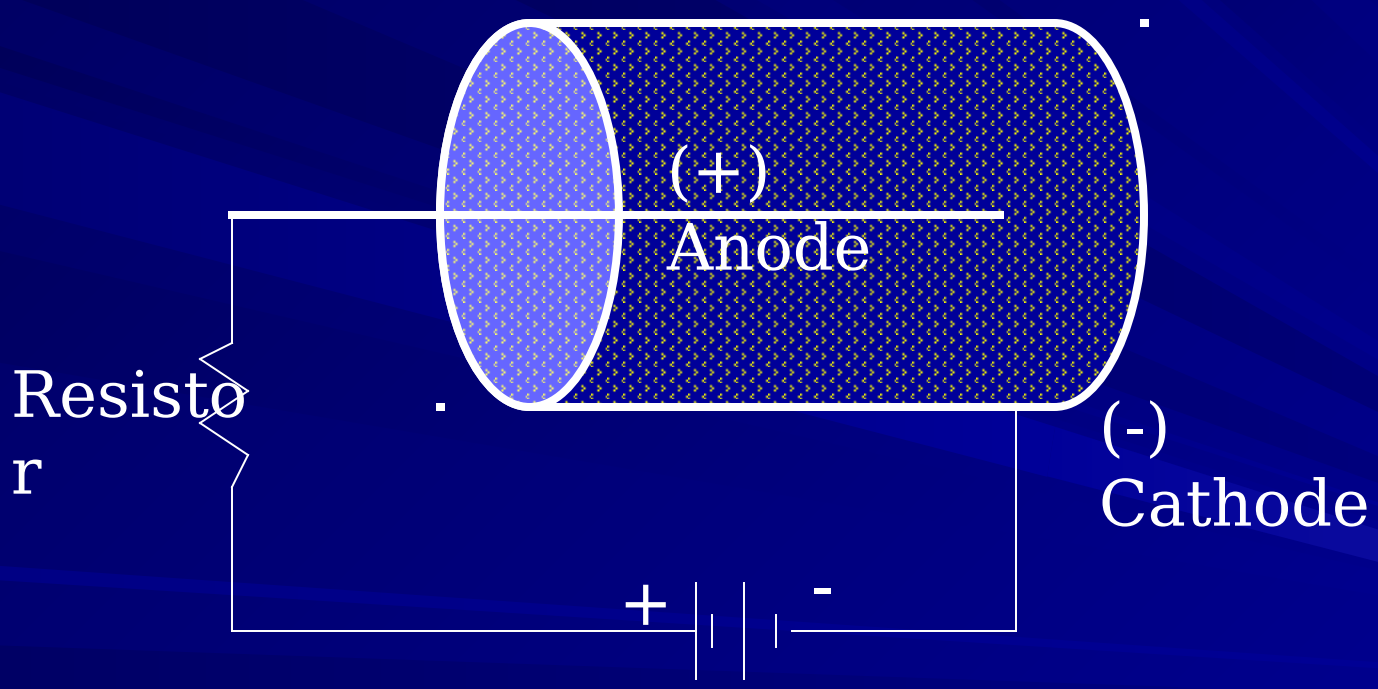
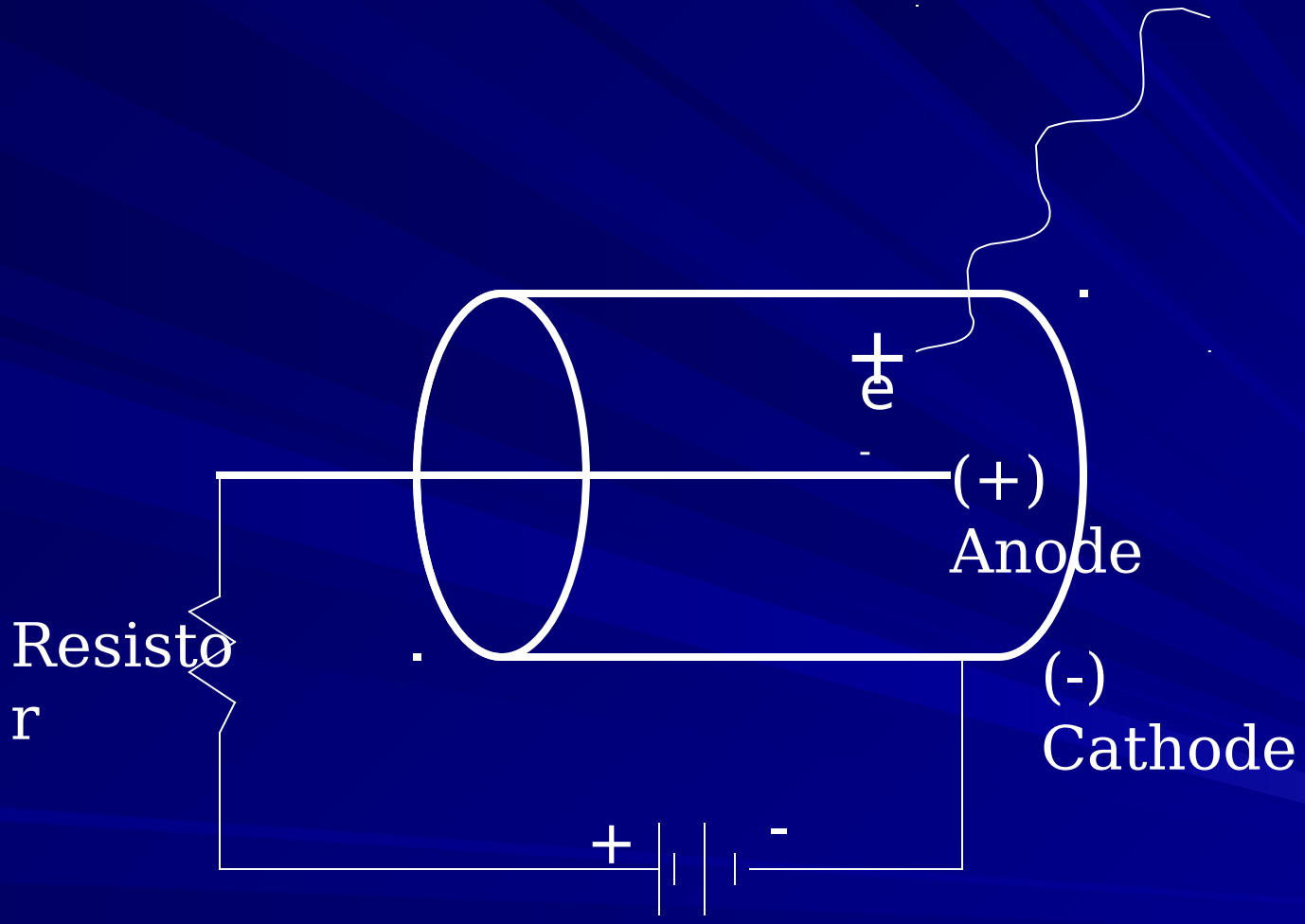
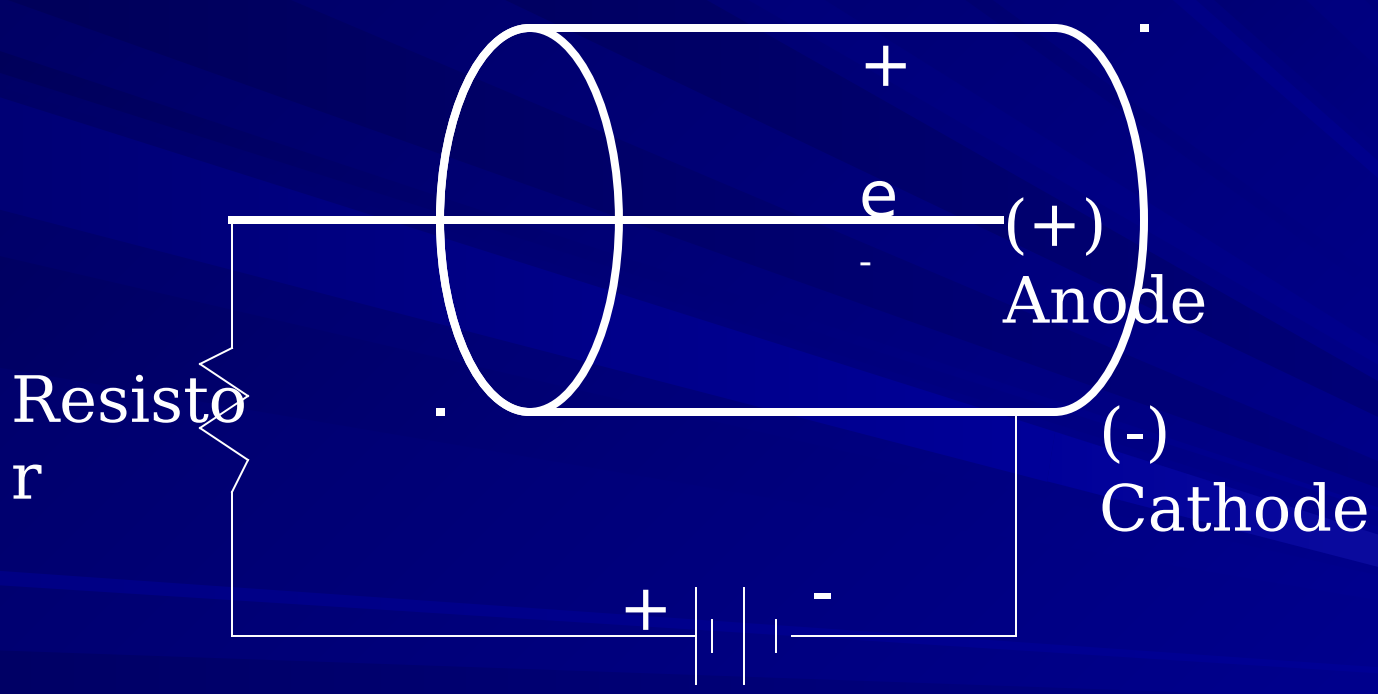
Gas Filled Detector (1)



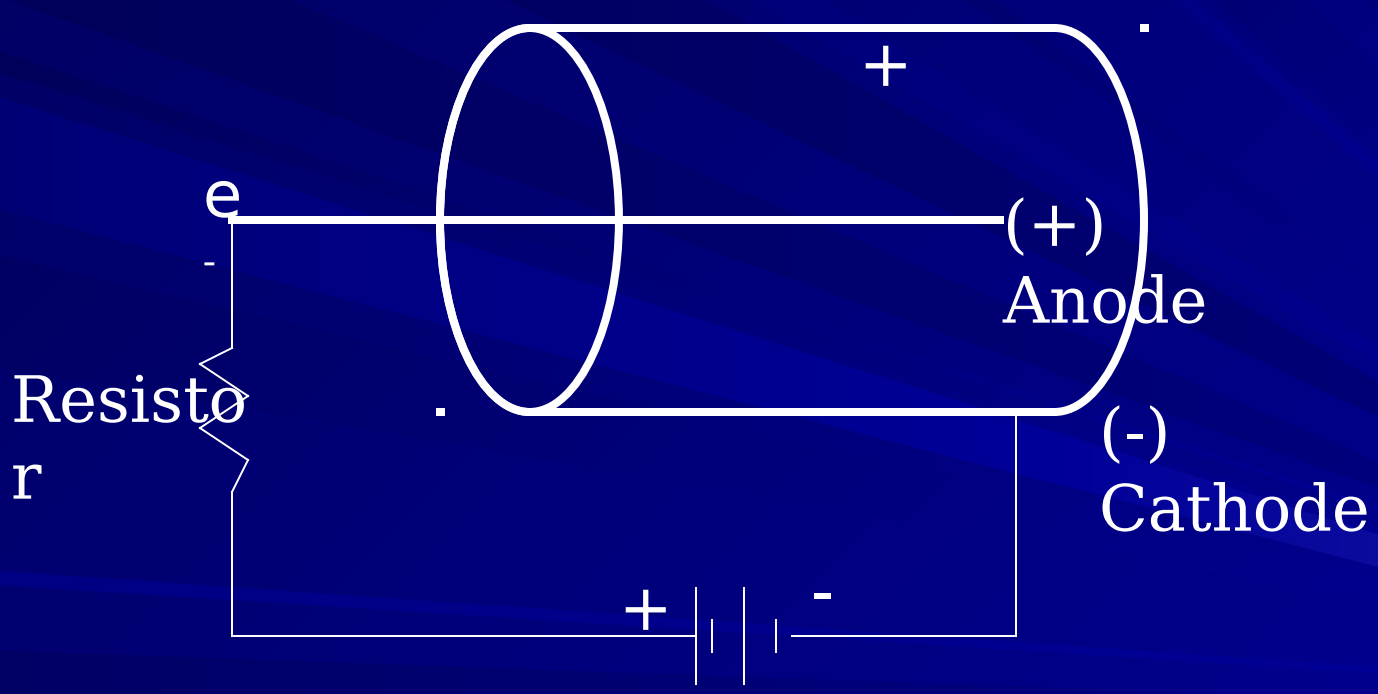
Gas Filled Detector (2)



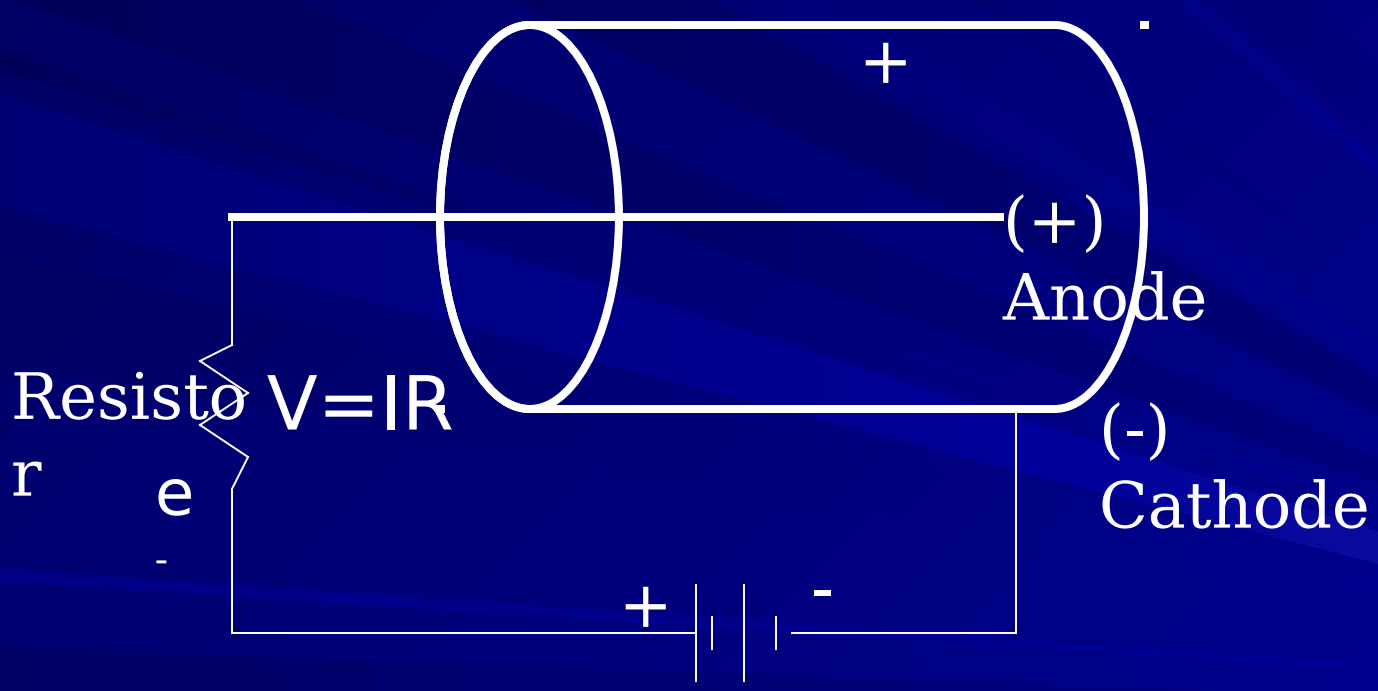
Gas Filled Detector (3)



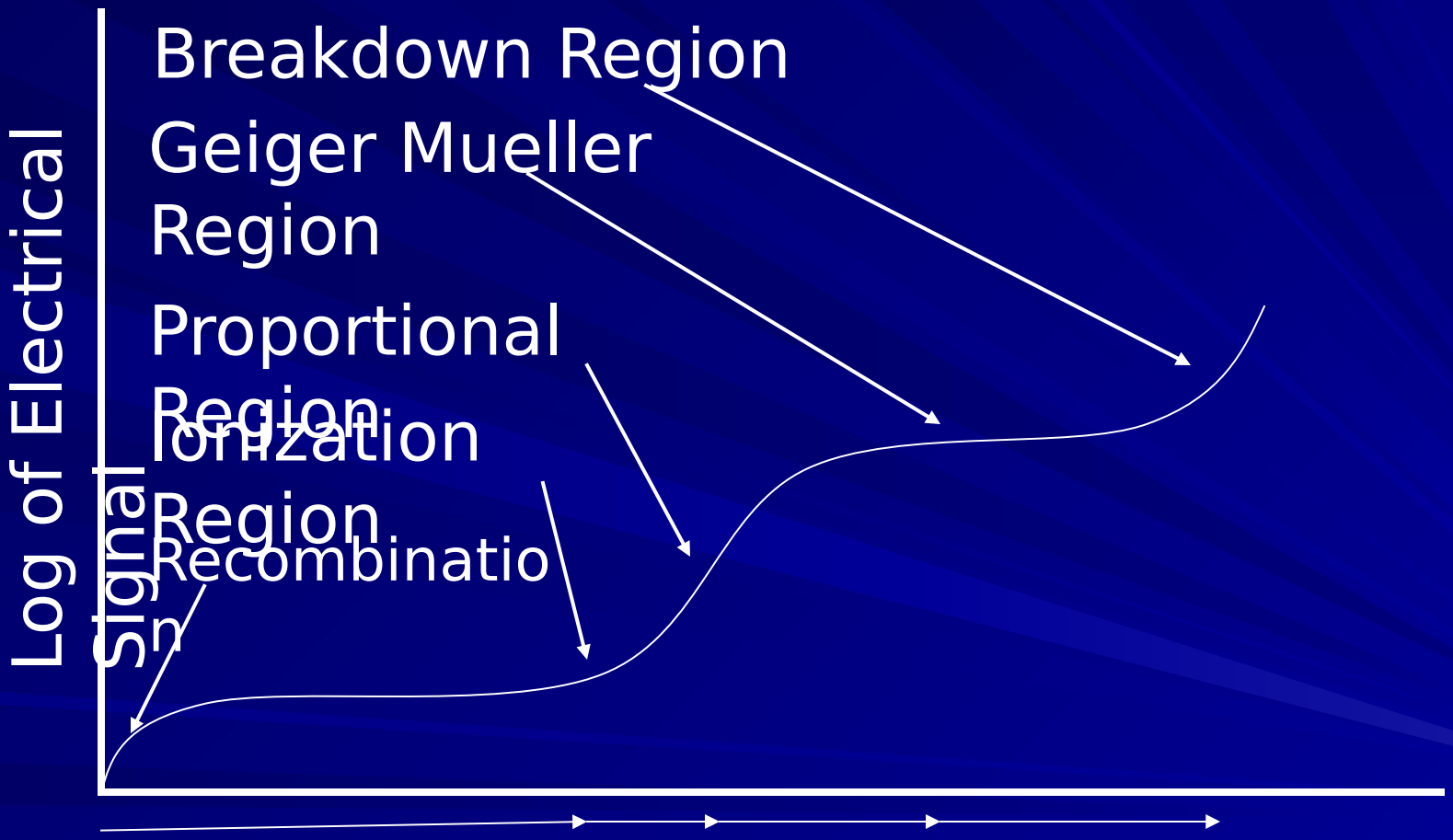
Gas Filled Detector (4)



Gas Filled Detector (5)

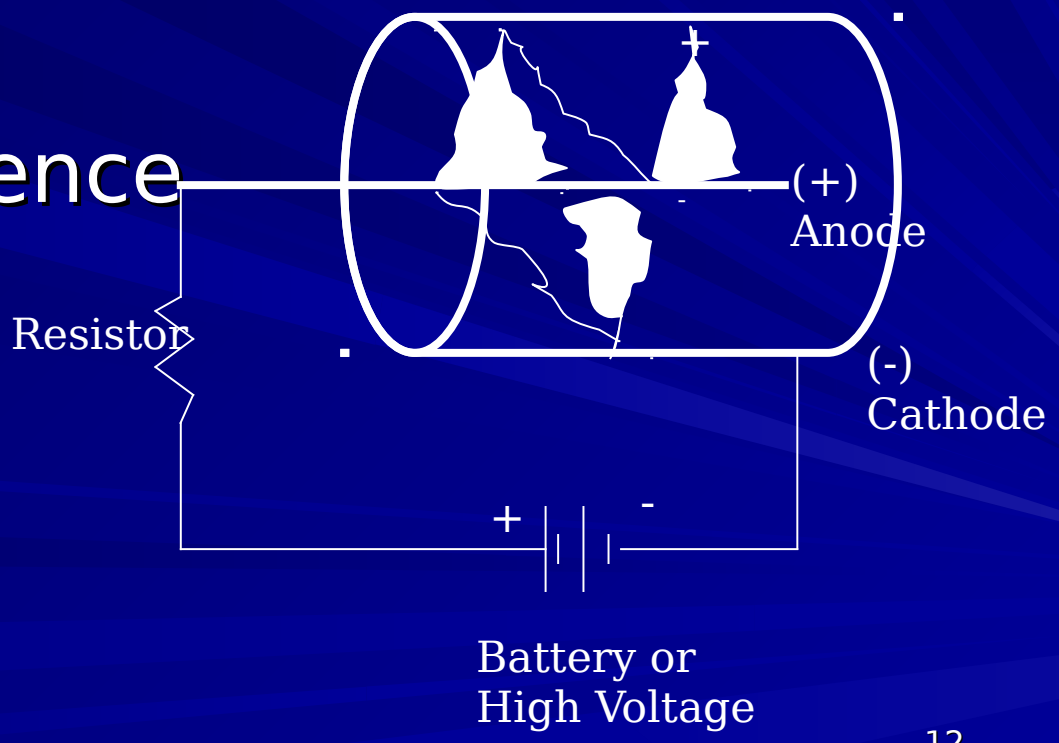


GAS FILLED DETECTOR
RESPONSE



Geiger Mueller Counter

- Most common type of detector
- Gas amplification
- Multiplication factor 10^8-10^{10}
- Long dead time
- Energy dependence
- Variety of uses
  - Count rate
  - Dose/Dose rate
  - Surface activity



Gas Filled Detector

AN/VDR-2

- Beta/Gamma Probe
- Measures and detects gamma photon energy
- Detects moderate to high energy Beta particle emission
- Neon-halogen gas (Gas Ionization)
- Display µGy and µGyph to Gy and Gyph
- Operates in GM region

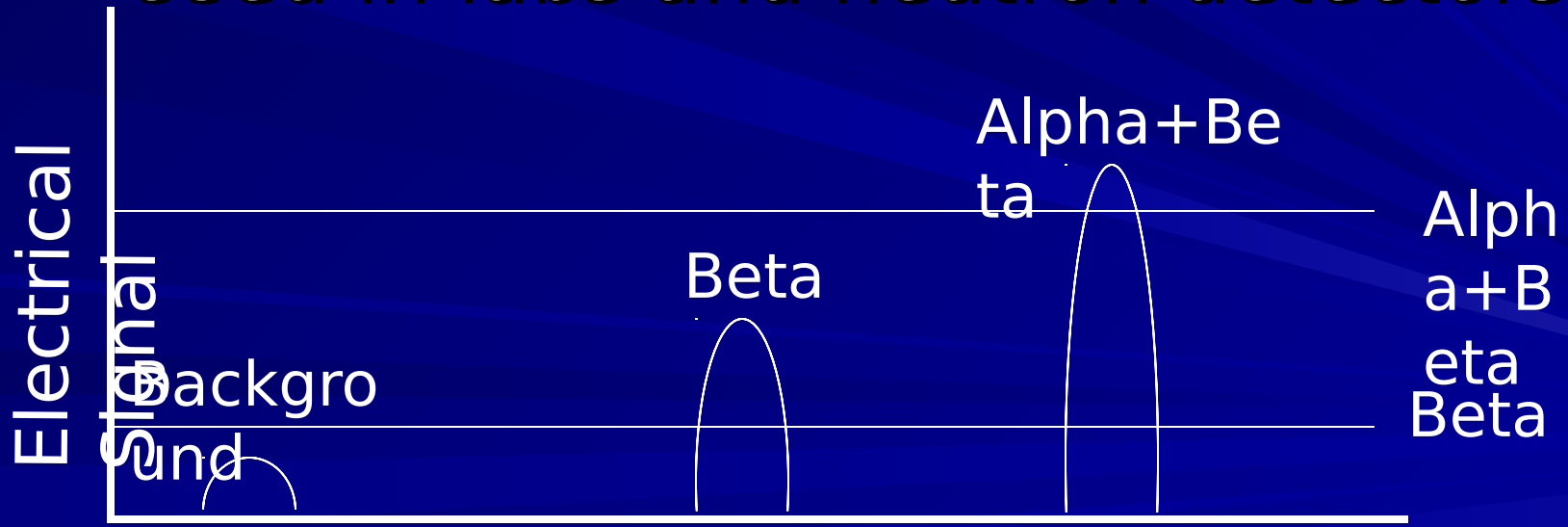
Gas Filled Detector

AN/PDR 77

- Beta/Gamma Probe
  - Measures and detects gamma photon energy
  - Detects moderate to high energy Beta particle emission
  - Neon-halogen gas
  - Display 0 – 999K mR/h
  - Operates in GM region

Proportional Counters

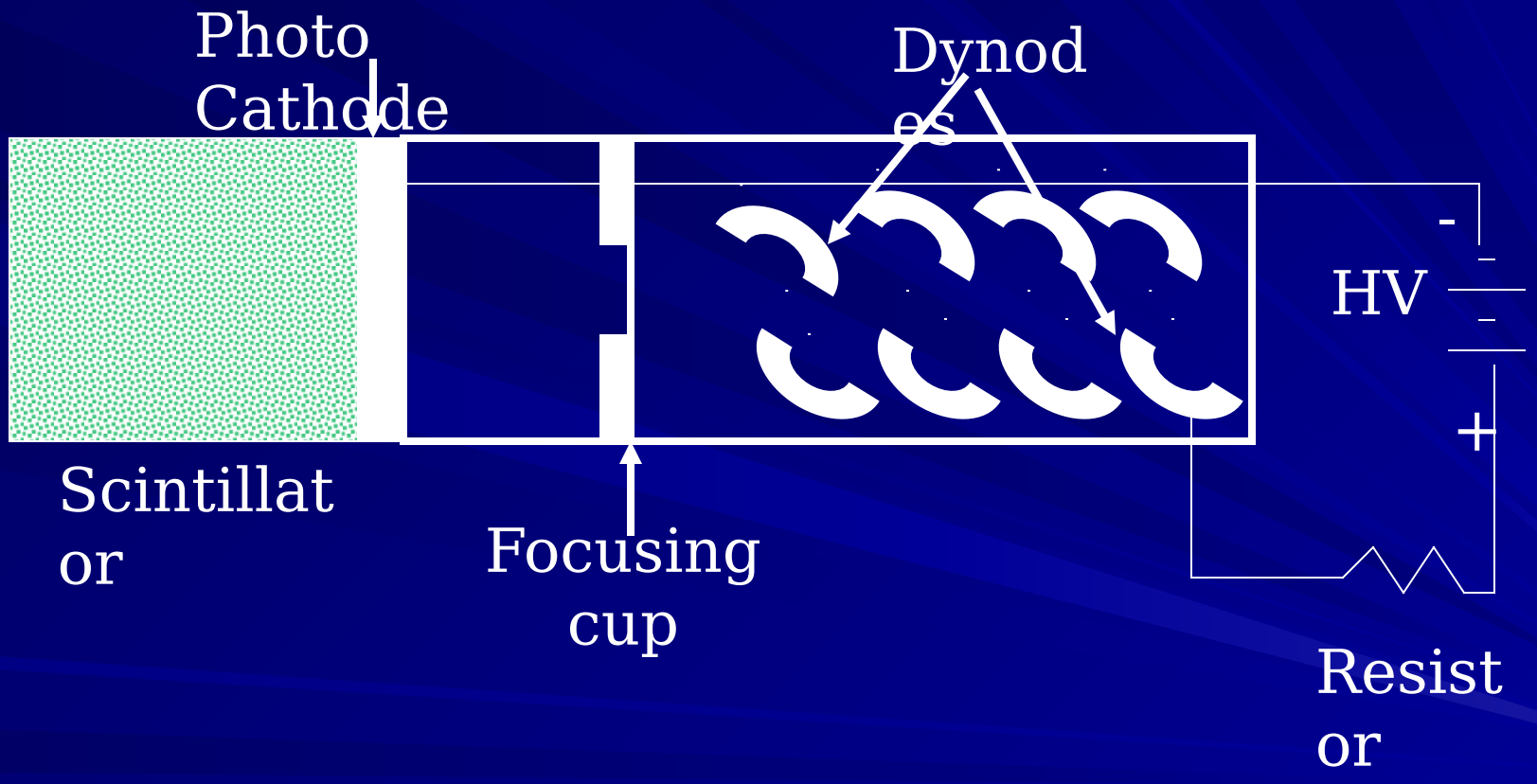
- Alpha-Beta discrimination
- Gas multiplication 10^6
- Low dead time
- Used in labs and neutron detectors



Proportional Counters

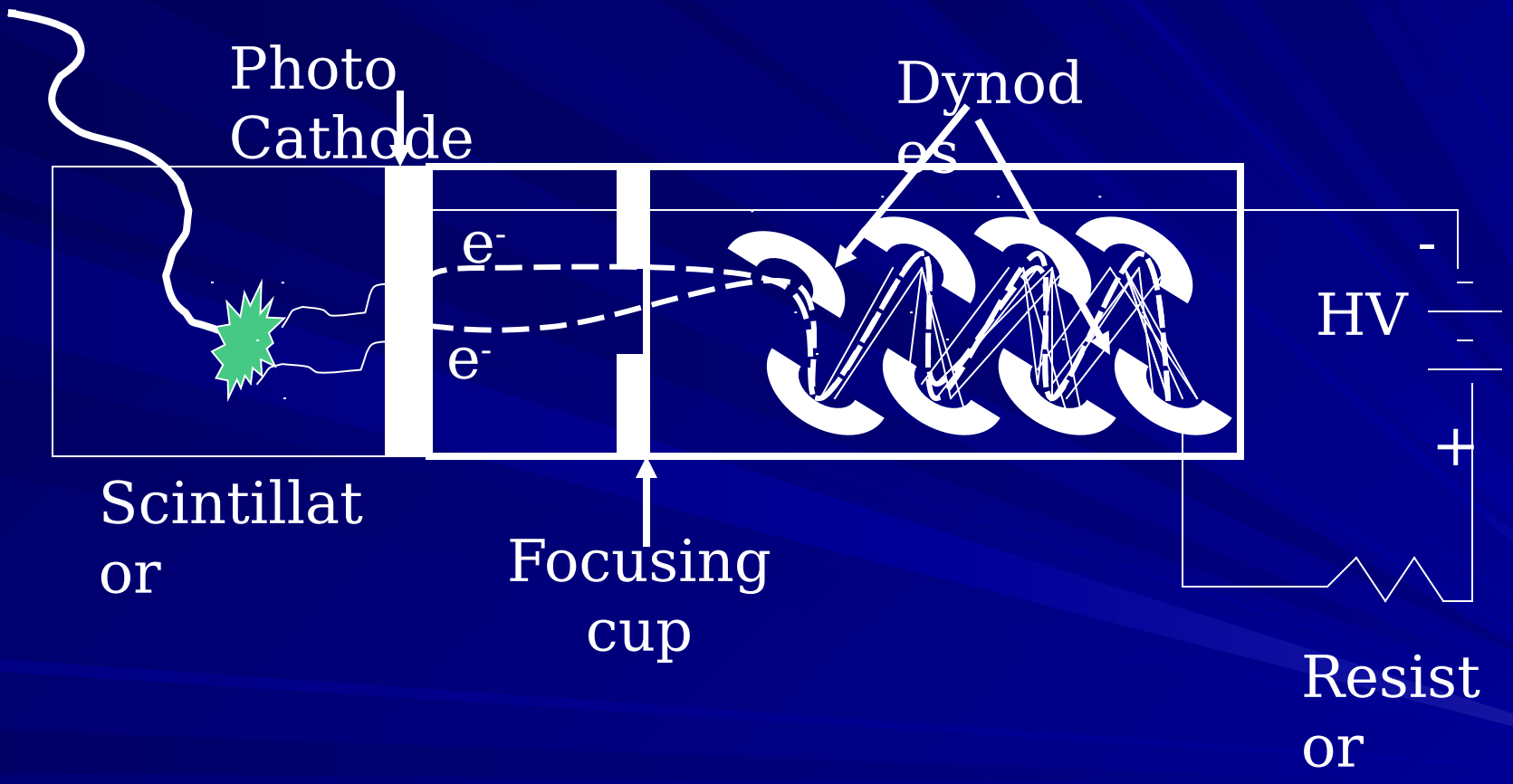
Scintillation Detector

(Light Production)



Scintillation Detector

(Light Production)



Scintillation Detector

AN/PDR 77

Alpha Probe (Zinc Sulfide (ZnS) Scintillator)

Measures and detects alpha particle radiation in disintegrations per minute (dpm).

X-ray Probe (Sodium Iodide (NaI) Scintillator)

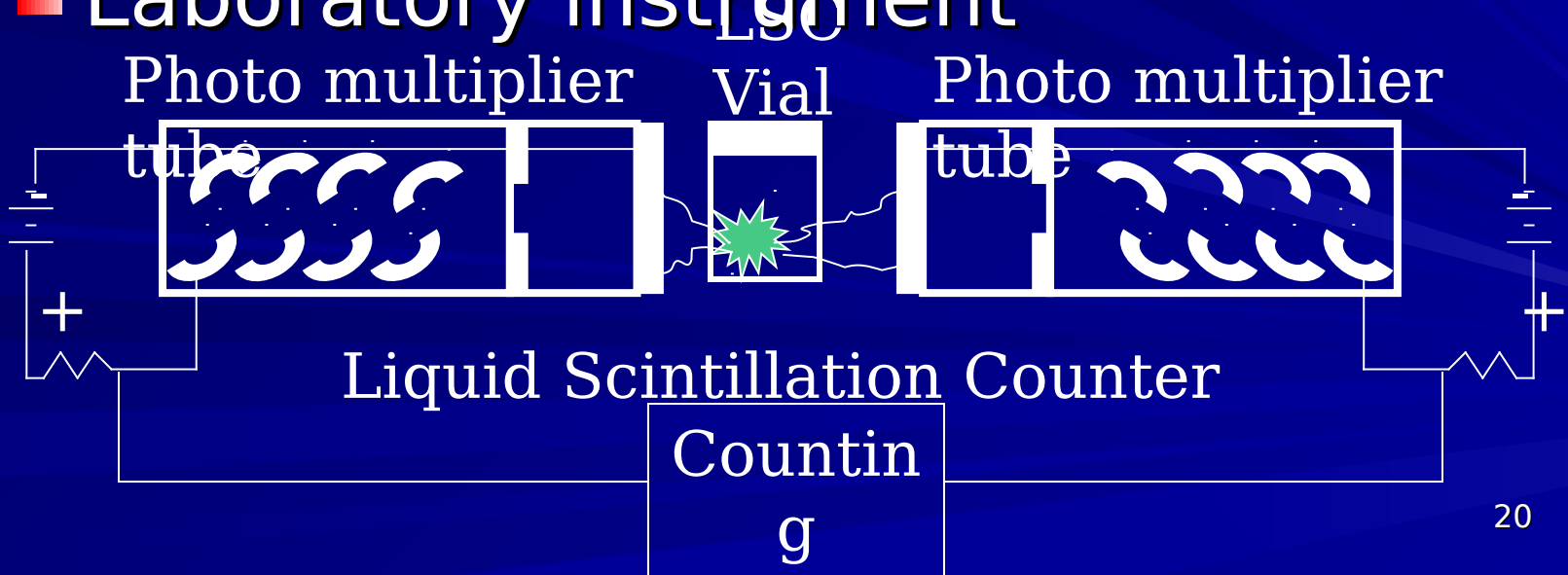
Primary use to detect fission isotopes

Measures and detects Pu^{239} & U^{235}

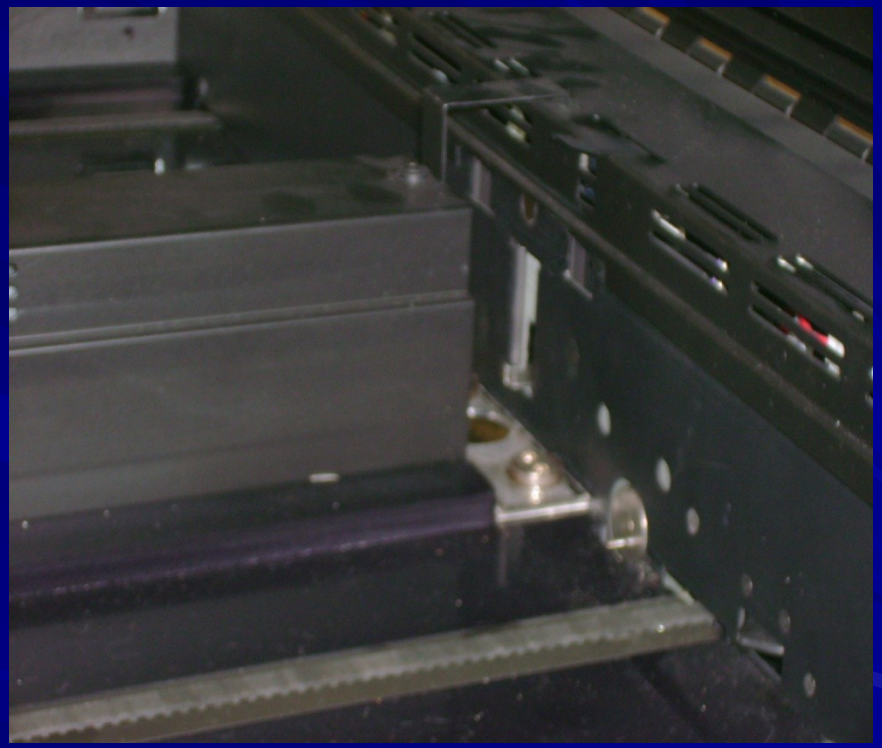
x-ray (17 keV & 60 keV average energies from the daughter products of Pu^{239} and U^{235}).

Liquid Scintillation

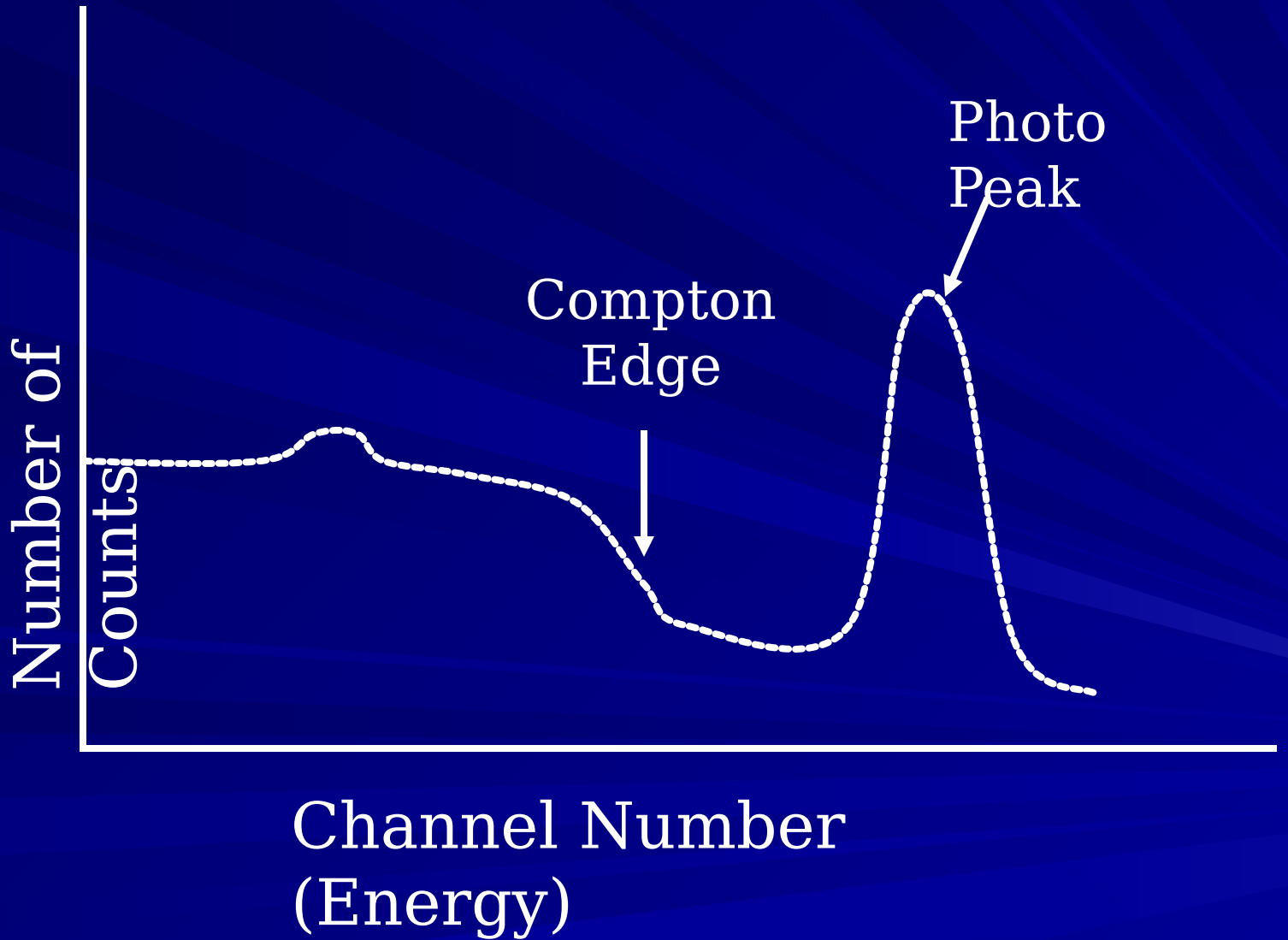
- Low energy beta and alpha
- Solvent mixed with scintillating material
- Very low background
- Laboratory instrument



Liquid Scintillation



Multi-Channel Analysis



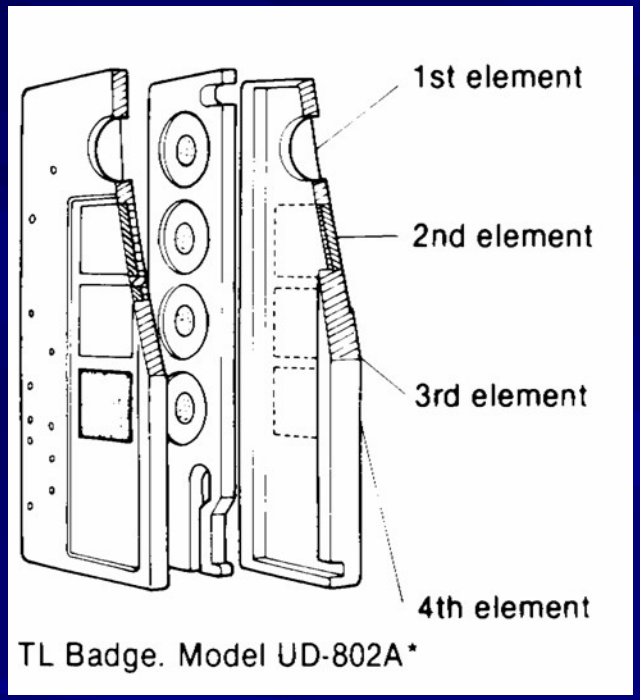
Multi-Channel Analysis

identiFINDER

Thermoluminescent Dosimeter

- Stores absorbed energy
- Crystalline material
- Read by heating and detecting emitted light
- Primary occupational dosimeter

Thermoluminescent Dosimeter



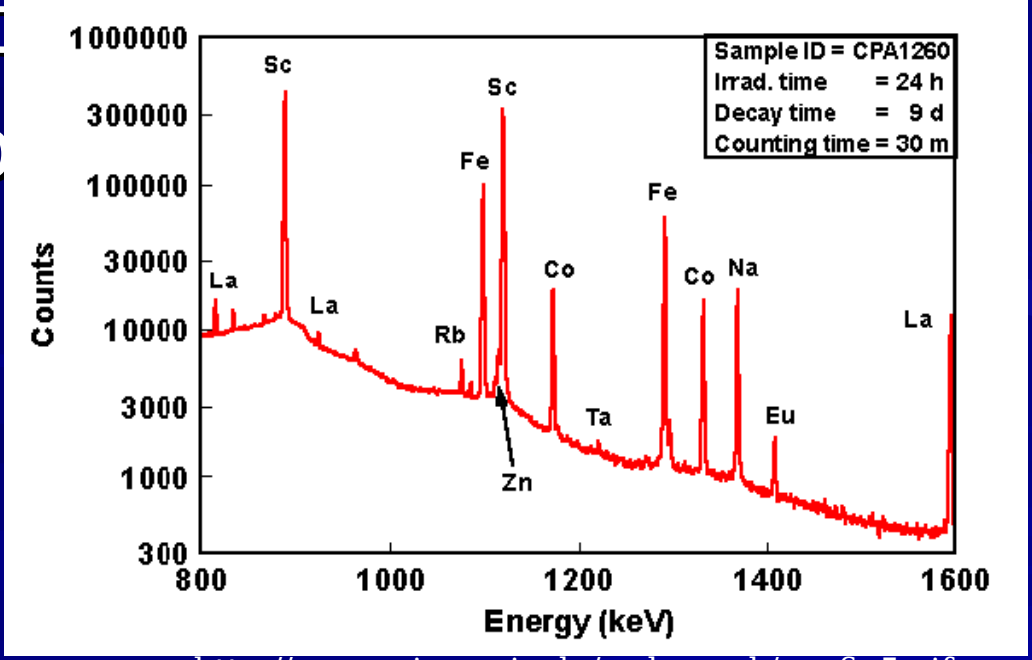
Panasonic UD-802AS Dosimeter

Whole Body and Wrist TLD Holders

Harshaw DXT-RAD Ring TLD

Semi Conductor Detectors

- High energy resolution
- Low efficiency for gamma (Diode Detector)
- High efficiency for gamma (Ge Detect
- Must b (PINS)



http://www.missouri.edu/~glascock/naafig5.gif

Semi Conductor Detectors

High-purity Germanium

Summary

- Principles of radiation detection
  - Electrical collection of ions
    - Gas ionization
    - Air ionization
  - Scintillation - Light production
- Characteristics of sensitive detectors
  - Dense detecting medium
  - High efficiency
  - Low background